Introduction of the Image Gently Campaign to Pediatricians using a series of Patient Presentation Modules Entitled “Commonly Requested but Misunderstood Imaging Studies” and self assessment exam

Tiffany Lewis BA1, Julianne Dean BA2, Lisa Lowe MD, FAAP3,4, Trent Phan DO4, Cynthia Taylor MD3,4

1 Kansas City University of Medicine and Biosciences, 2 Midwestern University Arizona College of Osteopathic Medicine Glendale, AZ, 3 Children’s Mercy Hospitals and Clinics, 4 University of Missouri Kansas City School of Medicine, Kansas City, MO
Learning Objectives

After viewing this exhibit the learner should:

• Become more familiar with the Image Gently Campaign

• Have increased knowledge on the indications for commonly requested but misunderstood imaging studies

• Be aware of a series of newsletters free to the public online
Outline

• Educational Campaign information
• Optional links to mini-discussions for commonly ordered but misunderstood studies
• Self-assessment exam
• Conclusion
• References
Introduction

• Recent studies suggest there has been a significant increase in the use of medical radiation, especially CT, from 2001 to 2006

• 7 million CT studies are done per year in the pediatric population and it increases 10% per year

• In 2004, a survey indicated only 9% of emergency physicians and 47% radiologists were aware of radiation risks from CT

• Multidetector CT and 3D imaging increase radiation dose by up to 30% or 3 to 10 times

Introduction

• In children, radiation induced cancer risk is increased due to younger age, lifespan, and increased sensitivity to radiation

• Our job as radiologists begins with helping clinicians determine study indications, and follows with ensuring appropriate imaging protocols

• Many practitioners are unaware of the Image Gently campaign

• A local education campaign can help get the word out about the Image Gently campaign
Purpose of Poster Presentation

• Given the increased use of medical imaging in children, especially CT, and the lack of knowledge regarding the risks to children in the general medical community, we set out to:
  – Educate practitioners on the image gently campaign
  – Educate practitioners on commonly requested but misunderstood studies

• Hopefully our educational campaign will help protect children from risk related to unnecessary radiation and sedation
The Society for Pediatrics Radiology (SPR) together with the American Academy of Pediatrics (AAP) along with 33 other medical organizations have formed a multidisciplinary group, the Alliance for Radiation Safety in Pediatric Imaging.

This organization represents over 400,000 healthcare professionals promoting appropriate and high quality CT for children.
Image Gently Campaign

- 4 simple guidelines:
  - Reduce or “child-size”
  - Scan only when necessary
  - Scan only the indicated region
  - Scan once; multiphase scanning is usually not necessary in children
- You can take the pledge online at:
  - http://www.pedrad.org/associations/5364/ig

Let’s increase the number pledged today!
Image Gently Pledge

Yes, I want to image gently.

Recognizing that every member of the imaging team plays a vital role in caring for the patient and wants to provide the best care, I pledge:

- to make the image gently message a priority in staff communications this year
- to review the protocol recommendations and, where necessary, implement adjustments to our processes
- to respect and listen to suggestions from every member of the imaging team on ways to ensure changes are made
- to communicate openly with parents. Thank you for committing to the goal to image gently when you image children. Spread the word in your department, practice, hospital or clinic.

First Name *

Last Name *

Email *

Professional Role *

Name of primary institution/hospital *

Primary Practice Type - Please check the description that most accurately reflects the location where you primarily practice

- Please make a selection

Other, please provide:

How did you learn about the Image Gently campaign?

Please make a selection

- AAPM
- AAP
- ACR
- Other, please provide
Imaging guidelines and appropriateness criteria can be found on the ACR website:

http://www.acr.org/s_acr/bin.asp?TrackID=&SID=1&DID=14800&CID=1848&VID=2&DOC=File.PDF
Imaging guidelines can also be found on the American Academy of Pediatrics (AAP) website at http://www.aap.org/sections/radiology/default.cfm. This also includes radiation safety information for parents.
Newsletter topics (mini-discussions)

- To enter mini-discussions click on topics to the right
- To skip mini-discussions and continue though the presentation, click anywhere

Sacral Dimples
Craniosynostosis
Torticollis
Macrocephaly
Vomiting child
Infant Hip Imaging/Limping Child

To exit any of the mini-discussions and return to this screen, click on the **underlined blue area** at the bottom of the slide.

To return to the start of the presentation click [here](#).
Sample newsletters:

- Image gently campaign

COMMONLY REQUESTED BUT MISUNDERSTOOD imaging studies

IMAGE GENTLY CAMPAIGN

Trent Phan, DO,1 Lisa Lowe, MD,2,3 and Cindy Taylor, MD,2,3
Department of Radiology, Children’s Mercy Hospitals and Clinics
Department of Radiology, University of Missouri-Kansas City

Since ascendancy of CT scans in the 1980s, the estimated number of studies performed has increased at least 800 percent.1 In children, the number of CT scans has increased 2.5 fold just between 1989 and 2001.2 With the advent of multidetector CT, radiation dose has increased approximately 30 percent with 3D studies adding 3 to 10 times more radiation. Recently an article in the New England Journal of Medicine emphasized that the risk of developing radiation induced cancer in children was increased due to their younger age, longer lifespan, and increased sensitivity to radiation.3

The Society for Pediatric Radiology (SPR) together with the American Academy of Pediatrics (AAP), and eleven other medical organizations have formed a multidisciplinary group, the Alliance for Radiation Safety in Pediatric Imaging. This organization represents over 400,000 health care professionals promoting appropriate and high quality CT for children.4 As part of its education and awareness initiative, the Alliance has developed the Image Gently Campaign. The campaign emphasizes four simple guidelines when imaging children:

1. Reduce or “child-size” the amount of radiation utilized.
2. Scan only when necessary.
3. Scan only the indicated region.
4. Scan once; multiphase scanning is usually not necessary in children.

The Image Gently Campaign Web site, www.imagegently.org, provides a wealth of information regarding CT usage in children, and is available to parents, radiologists, technologists, and clinicians. Another valuable resource to help clinicians decide which imaging study is the best study for a particular child, based on patient history, can be found at American College of Radiology (ACR) Web site: www.acr.org.

Here, various radiological studies have been rated, on a scale from 1 to 10 (best), by a group of multidisciplinary subspecialists as the most appropriate for a specific clinical condition. The appropriateness criteria can be downloaded to desktop computers or PDAs for easy access and reference.

As part of the overall initiative of the Image Gently Campaign, the Pediatric Radiology department at Children’s Mercy will be providing additional information through a series of articles called Commonly Requested, But Misunderstood Imaging Studies: What You Need to Know.

References

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Email: lwlowe@cmuh.edu
When it comes to imaging, one size does not fit all. The Image Gently campaign, launched by a multi-society consortium of physicians (including the American Academy of Pediatrics and Society of Pediatric Radiology), promotes not only a reduction in radiation exposure, but also a reduction in unnecessary imaging in children. In the current and upcoming articles, we will discuss commonly ordered, but often misunderstood imaging studies.

Sacral dimples are classified as either low or high risk. Low risk lesions do not require imaging (see table), where as high risk lesions do. Imaging may be accomplished with ultrasound in infants under 6 months of age and MRI imaging thereafter due to the limitations of ultrasound with progressive ossification of the spine. In general, ultrasound is the screening modality of choice. Exceptions include: dimples that are draining cerebrospinal fluid (sinus tracts); or open dysraphisms, which require immediate imminent surgery and/or MR imaging.

### Sacral Dimples

<table>
<thead>
<tr>
<th>Low risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midline</td>
<td>Greater than 5 mm in diameter</td>
</tr>
<tr>
<td>Less than 8mm in diameter</td>
<td>Greater than 2.5 cm above anus</td>
</tr>
<tr>
<td>Located within the gluteal crease</td>
<td>Located above the gluteal crease</td>
</tr>
<tr>
<td>(within 2.5 cm of the anus in infants)</td>
<td></td>
</tr>
<tr>
<td>No cutaneous abnormalities</td>
<td>Cutaneous abnormalities - hemangiomas, cutis aplasia, hairy patches, skin tags</td>
</tr>
<tr>
<td>No drainage</td>
<td>Draining cerebrospinal fluid</td>
</tr>
<tr>
<td>Can see bottom of the dimple</td>
<td>Bottom of dimple cannot be seen</td>
</tr>
</tbody>
</table>

Although Image Gently focuses mostly on the radiation risk associated with CT imaging, clinicians must recognize other imaging related risks, such as the sedation that is generally required for MR imaging in all children under 6 years of age. Timing of the imaging should be closely coordinated with the planned intervention or at least be delayed until the child is greater than 6 months of age, when there is decreased sedation risk. Finally, the judicious use of MR imaging may also help minimize the lengthy back log of patients who need MR imaging. Typically, each MR study occupies the MR scanner for about 1 hour, allowing only a few children to be imaged per day.

If you have questions or concerns regarding the imaging approach or modality to be used, help is available on line. The American College of Radiology (ACR) appropriateness criteria for nearly all imaging studies may be found on line at http://www.acr.org/SecondaryMainMenuCategories/quality_safety/acr_criteria/pdf.asp. You may also contact the Department of Radiology at Children’s Mercy Hospitals and Clinics at 913-588-3270.


Sample newsletters:

- Craniosynostosis
Sample newsletters:

• Imaging torticollis

<table>
<thead>
<tr>
<th>Clinical Presentation/Age</th>
<th>Initial Imaging approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3 months; asymptomatic except for torticollis</td>
<td>Ultrasound</td>
</tr>
<tr>
<td>&gt; 3 months; asymptomatic except for torticollis</td>
<td>No imaging; conservative Rx 1-2 weeks; Persistent symptoms – CT without contrast</td>
</tr>
<tr>
<td>Any age with history of trauma</td>
<td>CT with or without contrast</td>
</tr>
<tr>
<td>Any age with symptoms of infection</td>
<td>MRI</td>
</tr>
</tbody>
</table>

In infants under 3 months of age, especially those with prior forceps delivery, fibromatosis coli (hamartoma of the sternocleidomastoid muscle) is the most common cause of torticollis. It typically presents with torticollis and a “lump” in the sternocleidomastoid muscle between 6-12 weeks of age. Ultrasound is the initial study of choice in these otherwise asymptomatic infants as it provides reliable, cost-effective, diagnostic information without harmful radiation or sedation. Most cases of torticollis due to fibromatosis coli will spontaneously resolve, but persistent or severe cases may require physical therapy or, in rare cases, surgical release.

In children > 3 months of age, the most common cause of torticollis is idiopathic, self-limiting rotatory subluxation. If rotatory subluxation (torticollis) persists for several weeks despite conservative management, the child is at risk for rotatory fixation. Rotatory fixation is a more serious condition that may involve bony fusion and occasionally requires surgery. Unenhanced CT is the imaging study of choice to evaluate persistent unexplained, otherwise asymptomatic torticollis.

At any age, to evaluate trauma, the study of choice is unenhanced CT. In children of all ages with symptoms of infection, CT with contrast is the imaging modality of choice. Torticollis at any age associated with neurological signs or symptoms requires concern for spinal cord pathology and should be evaluated with MRI.

If you have questions or concerns regarding the imaging approach or modality to be used, help is available on line. The American College of Radiology (ACR) appropriateness criteria for nearly all imaging studies may be found online at [http://www.acr.org /SecondaryMainMenuCategories/quality_safety/app_criteria/pdfs.aspx](http://www.acr.org /SecondaryMainMenuCategories/quality_safety/app_criteria/pdfs.aspx). You may also contact the Department of Radiology at Children’s Mercy Hospitals and Clinics at 816-234-3270.

To learn more about the Imaging Gently Campaign, and take the pledge to reduce radiation in children along with thousands of other pediatric clinicians, please visit [http://www.pedrad.org/associations/5364/g/](http://www.pedrad.org/associations/5364/g/).

References:
Sample newsletters:

- Imaging macrocephaly

IMAGING MACROCEPHALY

Tiffany Lewis BA, Lisa H. Lowe MD, FAAP, and Cynthia Taylor, MD

Kansas City University of Medicine and Biosciences College of Osteopathic Medicine
Department of Radiology, Children’s Mercy Hospitals and Clinics

Reducions in both unnecessary imaging and radiation exposure in children are the focus of the Imaging Gently Campaign, a nationwide, multidisciplinary effort including organizations such as the American Academy of Pediatrics and the Society of Pediatric Radiology. In continued support of this campaign to reduce radiation and unnecessary imaging, we will discuss the imaging approach to macrocephaly.

Macrocephaly refers to a head circumference greater than two standard deviations above the mean (+2SD) for age, sex, race and gestation. The differential diagnosis of macrocephaly often includes the normal variation of benign enlarged subarachnoid spaces (BESS). Less often, it is due to a pathological state such as subdural hematoma, hydrocephalus and, extremely rarely, an intracranial mass. When imaging is considered, the type of imaging is based on the child’s development and age (see table below).

<table>
<thead>
<tr>
<th>Clinical Presentation &amp; Age</th>
<th>Imaging approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developmentally normal infant/child with open fontanel</td>
<td>Head ultrasound</td>
</tr>
<tr>
<td>Developmentally normal infant/child with closed fontanel</td>
<td>CT or MRI</td>
</tr>
<tr>
<td>Developmentally abnormal infant/child with open or closed fontanel</td>
<td>MRI</td>
</tr>
</tbody>
</table>

In developmentally normal infants (normal neurological exam) with open fontanels short term clinical follow-up with serial measurements of the head circumference alone with or without head ultrasound is reliable and safe [1]. If the head circumference stabilizes, imaging is not suggested. If the head continues to enlarge disproportionately to the child’s growth, ultrasound is useful to screen for hydrocephalus, or rarely, a mass so large it may cause macrocephaly.

In developmentally normal children with a closed fontanel, ultrasound is not possible. Instead, CT or MRI of the brain are required if imaging is performed. In these cases, the utility of close follow-up with serial head circumference measurements versus risks of imaging (radiation with CT or sedation risk with MRI) must be considered on a case by case basis [2]. In certain circumstances one mode of imaging may offer an advantage over the other, such as if visualization of the brain is important, then CT is preferred [3].

In developmentally abnormal infants or children, MRI is needed to carefully evaluate the brain parenchyma, as well as the extraxial spaces [2, 3]. Parenchymal brain signal changes of rare metabolic disorders, such as Alexander and Canavan disease, may present with macrocephaly and are best visualized with MRI.

Further information regarding the imaging approach to pediatric disorders may be found at the American College of Radiology Web site (imaging appropriateness criteria) at http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx. You may also contact the Department of Radiology at Children’s Mercy Hospitals and Clinics at 816-234-3270.

References:
**Sample newsletters:**

- Imaging the vomiting infant

**Imaging the vomiting infant**

Tiffany Lewis BA1, Steve T. Welch MD2,3, Lisa H. Lowe MD, FAAP1,2 and Cynthia Taylor MD,2,3
1Kansas City University of Medicine and Biosciences College of Osteopathic Medicine
2Department of Radiology, Children’s Mercy Hospitals and Clinics and the
3The University of Missouri-Kansas City

In continued support of the Imaging Gently Campaign, a nation-wide, multidisciplinary effort by organizations such as the American Academy of Pediatrics and the Society of Pediatric Radiology focused on reducing unnecessary imaging, radiation exposure and sedation in children, this Children’s Mercy newsletter we will discuss imaging of the vomiting infant.

The most common cause of infantile vomiting is gastroesophageal reflux disease (GERD). For the purpose of this discussion, we will assume the infant is a normal weight. Many healthy infants are expelled during nursing and non-traumatic gastrointestinal imaging (GIG) in order to rule out “GERD.” Since the UGI is a study of anatomy and not function, “GERD” is not typically an UGI diagnosis unless it is extremely severe. Functional studies to evaluate GERD such as pH probes and nuclear medicine often have better sensitivity and less radiation compared to an UGI. Proper imaging begins with knowing if the child’s vomiting is bilious or non-bilious, when the vomiting began, if any signs of airway compression are present, and the age of the child (see table).

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>Initial approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilious vomiting - This is an emergency. Refer to a pediatrician at your hospital.</td>
<td>NG tube confirmation and abdominal radiographs</td>
</tr>
<tr>
<td>Non-bilious vomiting (often since birth or normal weight gain)</td>
<td>If radiographs suggest a proximal obstruction (low or no dilated bowel loops) request a UGI as malrotation with midgut volvulus is most likely</td>
</tr>
<tr>
<td>Non-bilious vomiting + airway symptoms (cough, stridor)</td>
<td>If radiographs suggest distal obstruction (many dilated bowel loops); request contrast enema</td>
</tr>
<tr>
<td>Non-bilious vomiting in a 4 to 8-week-old</td>
<td>No imaging; GERD is most likely</td>
</tr>
<tr>
<td></td>
<td>Treat conservatively (anti-reflux meds)</td>
</tr>
</tbody>
</table>

Although proximal bowel obstruction in infants may be due to a variety of processes, malrotation with midgut volvulus is the most urgent concern and is diagnosed on UGI. It is important to rule that all pediatric UGI examinations include evaluation of the proximal small bowel by the level of the duodenal-jejunal junction and it is therefore not necessary to order a separate small bowel follow-through examination as part of the work up for malrotation with volvulus. Distal bowel obstructions, which are also due to a variety of process, are beyond the scope of this newsletter. Finally, some infants will require both an UGI and a contrast enema to evaluate for all urgent conditions.

- Non-bilious vomiting typically present since birth, is the most often due to GERD and no imaging is required. Infants with suspected GERD may be diagnosed by a trial of anti-reflux medications. However, if vomiting (GERD) is severe enough to cause the infant to lose weight, a GI or surgical consultation may be useful to determine the appropriate intervention.
- Non-bilious vomiting associated with airway symptoms (noisy breathing, stridor, cough) should be evaluated with an UGI to look for a vascular ring.
- Non-bilious vomiting in 4-8 week old infant is most often due to pyloric stenosis. Infants with pyloric stenosis often present with projectile vomiting and are easily diagnosed with pyloric ultrasound (transverse pyloric muscle measurement > 3mm).

To learn more about the Imaging Gently Campaign, and take the pledge to reduce radiation in children along with thousands of other pediatric clinicians, please visit http://www.pedrad.org/associations/939644/44.

Further information regarding the imaging approach to pediatric disorders may be found at the American College of Radiology website (imaging appropriateness criteria) at http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx or contact the Department of Radiology at Children’s Mercy Hospital and Clinics at 816-234-3570.

**References:**
Sample newsletters:

- Imaging the hip

IMAGING INFANT HIPS AND THE LIMPING CHILD

Julianne Dean BA¹, Brent Cutty MD², Lisa H Lowe MD FAAP ³, and Cindy Taylor MD²

¹Midwestern University, Glendale, AZ, ²Children’s Mercy Hospitals and Clinics, Kansas City, MO, and ³The University of Missouri-Kansas City

In continued support of the Image Gently Campaign, the Radiology Department at Children’s Mercy continues this newsletter series entitled “Commonly Requested but Misunderstood Imaging Studies” with a discussion on imaging infant hips and the limping child.

The most common reason for hip imaging in the newborn is hip dysplasia. Risk factors include being female, breech presentation, firstborn and family history of hip dysplasia (1).

Due to patient size and lack of epiphyseal ossification, ultrasound is the initial study of choice for possible hip dysplasia in children less than 6 months of age. After 6 months, radiographs of the pelvis are indicated.

In children with a limp or hip pain, the appropriate study (plain radiographs vs. ultrasound vs. MRI vs. bone scan) is strongly determined by the clinical history and physical exam. Specifically, one must know: (1) The child’s age (2) If a fever is present, how high (3) If there is hip pain with manipulation (4) Does the child refuse to bear weight and (5) If there are positive lab inflammatory markers (ESR, CRP) and if so, how positive? Using this information, it may be possible to distinguish viral versus bacterial joint infection versus osteomyelitis and determine the appropriate imaging.

<table>
<thead>
<tr>
<th>History and physical</th>
<th>Probable diagnosis</th>
<th>Imaging Modality of choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>No signs of infection (fever, WBC, sed rate, etc.)</td>
<td>Transient synovitis or AVN</td>
<td>• NO ACUTE IMAGING NEEDED</td>
</tr>
<tr>
<td>Minimal signs of infection</td>
<td>Transient synovitis</td>
<td>• Request radiographs if persistent</td>
</tr>
<tr>
<td>Many signs of infection &amp; Severe limp or refusal</td>
<td>Septic hip Osteomyelitis</td>
<td>• NO ACUTE IMAGING NEEDED</td>
</tr>
<tr>
<td>to bear weight and severe pain on passive exam</td>
<td></td>
<td>• Hip tap rarely for pain control</td>
</tr>
<tr>
<td>Many signs of infection &amp; No or mild limp and mild-</td>
<td>Osteomyelitis</td>
<td>• Refer to Emergency Department and/or Orthopaedic Surgery</td>
</tr>
<tr>
<td>moderate pain on passive exam</td>
<td></td>
<td>• Consider ultrasound to search for hip effusion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• MRI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For hip ultrasound as an effusion may be present, but may not need to be tapped</td>
</tr>
</tbody>
</table>

Children with transient (toxic) synovitis, are generally 3 to 8 years of age, present with a limp and less often refusal to bear weight. Symptoms usually resolve spontaneously within a few days. A low-grade fever may be present or the child may be febrile. Moderate pain is associated with passive motion of the hip on physical exam. NO IMAGING or HIP ASPIRATION is needed in children with toxic synovitis although many will have hip effusions. If symptoms persist, pelvic radiographs may be useful to evaluate for avascular necrosis.

Children with septic arthritis present at any age with a severe limp or inability to bear weight, fever, and guarding or severe pain with passive motion of the hip. In such cases, with a high suspicion of a septic joint, the child should be referred to an orthopedic surgeon who will usually aspirate the joint. Orthopedic surgery will determine whether to obtain an ultrasound (will show an effusion) or plain radiograph prior to hip joint aspiration.

Children with osteomyelitis of the hip are the trickiest because symptoms can mimic a septic hip joint in many ways. Osteomyelitis should be suspected when a child has a fever and positive inflammatory markers typical of septic joint; however, the degree of hip pain is mild to moderate with passive motion causing the child to limp rather than refuse to bear weight. Reactive joint effusions are often present with hip osteomyelitis, thus an ultrasound may be misleading. The modality of choice to evaluate osteomyelitis is MRI (2).

If there are concerns regarding imaging approach or modality to be used, the ACR appropriateness criteria may be found on line at http://www.acr.org/SecondaryMainMenuCategories/quality_safety/ app_criteria/pdf.aspx or you may contact the Department of Radiology at Children’s Mercy Hospitals and Clinics.

To learn more about the Image Gently Campaign and take the pledge to reduce radiation in children, please visit http://www.pedrad.org/associations/5364/gig/.

References
CMH website with downloadable newsletters

- These newsletters are being distributed to community practitioners.
- They are available on the Children's Mercy Hospital and Clinics Radiology website at:
- Use of these newsletters is open to the public.

Commonly Requested, but Misunderstood Imaging Studies

What You Need To Know

The articles below are provided as part of the overall initiative of the Image Gently Campaign. These articles have been prepared by the Pediatric Radiology department at Children's Mercy Hospitals and Clinics to inform clinicians regarding commonly requested, but misunderstood imaging studies.

- Image Gently Campaign
- Imaging of Skeletal Disorders
- Imaging for Spina Bifida
- Imaging Torticollis
- Imaging Microcephaly
- Imaging the Vomiting Infant

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Self-Assessment Exam

- Welcome to the self assessment exam where you can see what you have learned
- Please answer the next 5 questions by clicking True or False
- Follow prompts on screen to obtain the correct answer and move on to the next question
Self-assessment Exam: Question #1

**True** or **False**

Boys are twice as sensitive to radiation as girls.
Radiation Sensitivity

True is not the correct answer, good try.

Move to correct answer

Return to list of minidiscussions or click anywhere to continue with next topic
False, good job!

Actually girls are twice as susceptible to carcinogenesis as boys.

Self Assessment Exam:
Question #2

True or False
Infants are up to 15 times more sensitive to radiation than adults.
Radiation Sensitivity

False, nice try but incorrect.

Move to correct answer
Radiation Sensitivity

True! Correct.

“Because they have more rapidly dividing cells than adults and have a longer life expectancy, the odds that children will develop cancer from x-ray radiation are higher than adults.”

True or False

3D CT should be utilized as a screening test for children suspected of having craniosynostosis.
3D CT

True, nice try, but incorrect.

Move to correct answer
3D CT

False, good job!

3 dimensional CT adds 3-10 times more radiation and is mostly reserved for surgical planning.
True or False

It has been estimated that radiation from CT may cause up to 1:1,000 neoplasms.
Cancer

False. Nice try!

Move to correct answer

Return to list of minidiscussions or click anywhere to continue with next topic
Cancer

True.

It has been estimated that CT may cause up to 1 in 1,000 neoplasms

Brenner, DJ. Estimating cancer risks from pediatric CT: going from the qualitative to the quantitative. Pediatric Radiology 2002; 32: 228-231

Click anywhere to move to next question
True or False

Many pediatric radiologists estimate that greater than 30 percent of CT scans are unneeded.
Need for scans

False. Incorrect, but good try.

Move to correct answer

Return to list of minidiscussions or click anywhere to continue with next topic
Need for scans

True. Nice job!

“A poll might show that we consider 10% to 30% of our CT examinations unnecessary. A nonscientific consensus at the ALARA conference was that about 30% of CT examinations in children were totally unnecessary or were readily replaceable by examinations not using radiation.”


Please click anywhere for references and conclusion.
Conclusion

• The newsletters in this presentation are available to the public on the internet and are not copyright protected

• They were distributed to 4,500 primary care physicians, nurse practitioners, and physician assistants in MO and KS along with our medical staff
Conclusions

• This ends the presentation on our education campaign

• If you wish to go to the list of mini-discussion topics click here

• Return to beginning of presentation by clicking here

• Click anywhere for references

• Thank you for your attention!
References


Imaging sacral dimples: US or MRI?

- Sacral dimples are common and usually of no significance
- US is the modality of choice in infants < 4-6 months age
  - Sedation risk is higher < 6 months age
- MRI is the modality of choice > 6 months age
- If surgery is planned, it is useful to delay imaging until surgery is imminent

Caveat: MRI is the study of choice in a child of ANY age with a draining dimple
### Sacral Dimples: Imaging Low versus High Risk lesions

<table>
<thead>
<tr>
<th>Low Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midline</td>
<td>Off midline</td>
</tr>
<tr>
<td>&lt; 5mm</td>
<td>&gt; 5mm</td>
</tr>
<tr>
<td>Within 2.5 cm of anus</td>
<td>&gt; 2.5 cm from the anus</td>
</tr>
<tr>
<td>No cutaneous abnormalities</td>
<td>Cutaneous abnormalities (i.e. hemangiomas, cutis aplasia, hairy patches, skin tags)</td>
</tr>
</tbody>
</table>

*Return to list of minidiscussions or click anywhere to continue with next topic*
Sacral Dimples with cutaneous stigmata: High risk

Hemangioma

Myelomeningocele with skin covering

Sacral dimple above gluteal crease

Hairy patch

Return to list of minidiscussions or click anywhere to continue with next topic
2 children with dimples above the gluteal crease

US—Child less than 6 months of age
Dimple that extends to the dural but does not violate it

MR—Child greater than 6 months of age

Normal US—conus at L2

Return to list of minidiscussions or click anywhere to continue with next topic
Craniosynostosis Imaging

Imaging is based on 3 categories:

1. **Low risk** - Developmentally normal or posterior flattening only
   - Plain films (4 view skull)

2. **Intermediate risk** - Healthy children with head deformity
   - CT head

3. **High risk** - Obviously misshapen head
   - 3D CT needed for surgical planning

Return to list of minidiscussions or click anywhere to continue with next topic
## Craniosynostosis: Low vs. intermediate vs. high risk imaging

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Imaging modality recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk—developmentally normal and posterior flattening only</td>
<td>4 view skull (plain films)</td>
</tr>
<tr>
<td>Intermediate risk—healthy children with head deformity</td>
<td>CT Head</td>
</tr>
<tr>
<td>High risk—developmentally abnormal children and/or children with obvious head deformity almost certainly needing surgery</td>
<td>3D Head CT</td>
</tr>
</tbody>
</table>
Craniosynostosis: Low Risk

History: Developmentally normal child with posterior flattening

Diagnosis: Normal sutures
Craniosynostosis: Intermediate Risk

History: Developmentally delayed child with parieto-occipital flattening

**Diagnosis:** Plagiocephaly (parieto-occipital flattening, but no craniosynostosis)
Craniosynostosis: High Risk

History: Child with obvious abnormally shaped head

Diagnosis: Sagittal synostosis

Diagnosis: Lambdoid synostosis
Imaging Torticollis: Based on age and history

• Infant with torticollis:
  – Most often due to fibromatosis coli (hematoma of sternocleidomastoid muscle)
  – More common in forceps delivery
  – Sonography is diagnostic
  – Rx: Physical therapy or surgical release

• Beyond young infants the work up depends on history
Torticollis: Beyond infants

• History of isolated torticollis (no trauma)
  – Usually rotatory subluxation (self-limiting, due to muscle spasm)
  – No imaging needed unless persistent after a week or 2 of conservative treatment
  – Isolated, persistent – do CT then consider dynamic scan with head in neutral, right, and left positions

• History of trauma
  – Plain films or CT without contrast

• History of sore throat/signs of infection
  – CT with contrast

• History of torticollis with neurological signs
  – MRI
Infantile Torticollis

Hx: 6-week-male with torticollis and forceps delivery

Diagnosis: Fibromatosis coli
Isolated Torticollis in a child

History: 10-year-old male awakened with neck stuck to left 1.5 weeks ago; No response to conservative treatment

Coronal image demonstrates asymmetry between C1 and C2

Notice abnormal widening between C1 and dens widens with head turning to the left (toward torticollis)

Notice normalization of distance between C1 and dens with head turning to the right (away from torticollis)

Diagnosis: Rotatory Subluxation
Isolated persistent torticollis

Diagnosis: Rotatory Fixation

History: 15-year-old male with neck "stuck to the right" after "neck adjustment"

Normal alignment

Abnormal alignment with head turning right

Note C1 is looking a different direction than C2-C7
Torticollis with fever

History: 1-year-old female with sore throat and difficulty swallowing

Axial CT neck demonstrates fluid pockets both on the right and at midline

Lateral view of the neck demonstrates prevertebral swelling of soft tissues

Diagnosis: Peritonsillar and retropharyngeal infection
Torticollis with neurological symptoms

History: 1-yr-old female with persistent torticollis & scratching of the left arm

Diagnosis: Spinal cord astrocytoma

Return to list of minidiscussions or click anywhere to continue with next topic
# Imaging torticollis based on history

<table>
<thead>
<tr>
<th>Clinical history and age</th>
<th>Initial imaging approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3 months; asymptomatic except for torticollis</td>
<td>Ultrasound</td>
</tr>
<tr>
<td>&gt; 3 months; asymptomatic except for torticollis</td>
<td>No imaging; conservative Rx 1-2 weeks; Persistent symptoms – CT without contrast</td>
</tr>
<tr>
<td>Any age with history of trauma</td>
<td>CT without contrast</td>
</tr>
<tr>
<td>Any age with symptoms of infection</td>
<td>CT with IV contrast</td>
</tr>
<tr>
<td>Any age with neurological symptoms</td>
<td>MRI</td>
</tr>
</tbody>
</table>

Return to list of minidiscussions or click anywhere to continue with next topic
Imaging macrocephaly

**Definition**: Head greater than 95%
- If the head circumference levels out—no imaging
- If the head growth rate continues to increase or developmental abnormality, do imaging

**Imaging approach**:
- **US** is used if the child is **less than 6 months** or if they still have an open fontanelle
- **CT** is used if the child is **greater than 6 months** and no fontanelle
- **MRI** if associated neurological symptoms
# Imaging macrocephaly

## Clinical presentation and age

<table>
<thead>
<tr>
<th>Developmentally normal infant/child with open fontanelle</th>
<th>Head ultrasound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developmentally normal infant/child with closed fontanelle</td>
<td>CT or MRI</td>
</tr>
<tr>
<td>Developmentally abnormal infant/child with open or closed fontanelle</td>
<td>MRI</td>
</tr>
</tbody>
</table>
Macrocephaly: developmentally normal child with open fontanelle

History: Normal subarachnoid space contains vessels

Diagnosis: Benign enlarged subarachnoid spaces

Return to list of minidiscussions or click anywhere to continue with next topic
Benign enlarged subarachnoid spaces (BESS)

- Usually presents between 3 months and 3 years of age (esp. 6-18mo)
- Most common cause of macrocephaly in a developmentally normal child
- Parents often have big head
- Resolves spontaneously
Macrocephaly in a neurologically abnormal child

- 4-month-male with macrocephaly and lethargy

Diagnosis: Choroid plexus papilloma
Vomiting infant: Imaging

• **3 categories:**
  
  • **Bilious vomiting** – EMERGENCY
    – Confirm with NG tube & get UGI
  
  • **Nonbilious vomiting since birth**
    – Not an emergency, and often gastroesophageal reflux
    – Do not need UGI
    – Rx: Anti-reflux meds or surgical consult
  
  • **Projectile vomiting first occurring after several weeks of life**
    – Ultrasound for Pyloric stenosis

Return to list of minidiscussions or click anywhere to continue with next topic
### Vomiting Infant: Bilious

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>Initial Approach</th>
</tr>
</thead>
</table>
| Bilious Vomiting — Emergency, refer to pediatric facility | NG tube and abdomen radiographs:  
  - If radiographs suggest proximal obstruction (few or no dilated bowel loops) request UGI as malrotation with midgut volvulus is most likely  
  - If radiographs suggest distal obstruction (many dilated bowel loops) request contrast enema first  
  - May need to do both UGI and enema  
  - No need for small bowel follow through |
### Vomiting Infant: Non-bilious

| Non-bilious vomiting | • With normal weight gain (often since birth) | • No imaging; GERD most likely  
| | | • Treat conservatively with anti-reflux meds |
| Non-bilious vomiting | • With airway symptoms (cough, stridor) | • Request UGI  
| | | • Vascular ring is most likely  
| | | • No need for small bowel follow through |
| Non-bilious vomiting | • 4 to 8 week old | • Pyloric ultrasound  
| | | • Pyloric stenosis most likely  
| | | • No need for UGI or small bowel follow through |

Return to list of minidiscussions or click anywhere to continue with next topic
Vomiting Infant: Bilious

History: 6-day-male with bilious vomiting

Diagnosis: Malrotation with midgut volvulus

Abdomen radiograph shows a nonspecific bowel gas pattern with paucity of gas.

UGI reveals obstruction of contrast at the 2nd portion of the duodenum. The contrast column corkscrews down into a beak.

Diagnosis: Malrotation with midgut volvulus
Vomiting Infant: Non-bilious

History: 4-week-male with non-bilious vomiting

Diagnosis: Pyloric stenosis

- US shows a thickened (>3mm), elongated pyloric channel (>15mm)

Return to list of minidiscussions or click anywhere to continue with next topic
Imaging the hip: Infants

• If you suspect hip dysplasia:
  – Child age < 4-6 months—ultrasound
  – Child age > 4-6 months—plain radiograph

Return to list of minidiscussions or click anywhere to continue with next topic
## Imaging the hip: Beyond infants

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>Imaging Study based on degree of suspicion for septic hip</th>
</tr>
</thead>
</table>
| No signs of infection (fever, WBC, ESR) with limp         | • Low suspicion - likely toxic synovitis  
• No imaging needed  
• If persistent consider plain radiographs for AVN |
| Signs of infection with mild hip pain or limp             | • Intermediate suspicion - MR to evaluate for possible osteomyelitis                          |
| Signs of infection with severe pain, decreased ROM, and severe limp or refusal to walk | • High suspicion for septic hip — emergent hip joint tap indicated with or without ultrasound depending on surgeon preference |

Return to list of minidiscussions or click anywhere to continue with next topic
Infant hip < 6 month age

- History: Newborn infant with breech delivery
- Ultrasound shows dislocation of both femoral heads

Femoral heads are not yet ossified and cannot be seen on hip radiographs

**Diagnosis: Hip dysplasia**

Return to list of minidiscussions or click anywhere to continue with next topic
Child: Intermediate suspicion for septic hip

- 4-year-male with fever, moderate hip pain & limp
- MRI: Enhancing femoral neck/head with associated small effusion

**Diagnosis:** Osteomyelitis
Child: High suspicion for septic hip

- 3-year-male with fever, severe hip pain and refusal to walk

**Diagnosis:** Septic hip

Normal - no fluid

Abnormal - joint effusion

Return to list of minidiscussions or return to start of presentation by clicking here